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March 2, 2006

Statement of

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before the
Committee on Science
House of Representatives

Mr. Chairman and Members of the Committee, thank you for this opportunity to appear before you today to discuss NASA's Science program and our plans as represented in the President's FY 2007 budget request for NASA.

The past year has been one of significant achievement for NASA's science missions. The Voyager 1 spacecraft entered the vast, turbulent expanse of the heliosheath, 8.7 billion miles from the sun, where no human-made object has traveled before. The Hubble Space Telescope continues its successful mission of discovery and exploration. Among its many achievements was the discovery that Pluto may have three moons, offering more insights into the nature and evolution of the Pluto system and Kuiper Belt. Through coordination of observations from several ground-based telescopes, NASA's Swift spacecraft and other satellites, scientists solved the 35-year old mystery of the origin of powerful, split-second gamma-ray bursts. Using data from NASA's Aura satellite, NASA and National Oceanic and Atmospheric Administration (NOAA) researchers found they could improve the accuracy of six-day forecasts by up to six hours. The ICEsat tracked significant changes in Arctic sea ice, and the GRACE satellite made the first direct comprehensive mass survey of the Greenland ice sheet. Deep Impact traveled 268 million miles to meet comet Tempel 1, sending its impactor to collide with the comet and providing researchers with the first look inside a comet. The Mars twin rovers continue studying the harsh Martian environment, well beyond their expected mission life. Among its many achievements, Cassini has taken spectacular images of Saturn, its rings, and its amazing variety of moons. The European Space Agency's Cassini-Huygens probe successfully descended through the murky atmosphere of Saturn's largest moon, Titan, revealing some of its "Earth-like" features. The Mars Reconnaissance Orbiter (MRO) successfully launched, and, next week, will go into orbit around Mars, providing high resolution imagery of the Martian surface and more data than all previous planetary missions combined. MRO will zoom in for extreme close-up photography of the Martian surface, analyze minerals, look for subsurface water, trace the amount of dust and water in the atmosphere, and monitor the daily global weather. And on January 19, 2006, the New Horizons mission successfully launched, beginning its nine-year journey to Pluto. We are now looking forward to the upcoming launches of New Millennium's ST-5, CloudSat and CALIPSO, TWINS-A, CINDI, and STEREO.

FY 2007 Budget Request

NASA's FY 2007 budget request provides $5.33 billion for the Agency's Science portfolio to explore the universe, solar system, and Earth. As Administrator Griffin testified on February 16, the decision to slow the rate of growth for NASA's Science missions is a matter of how the Agency will use the available resources within the overall NASA portfolio. Thus, NASA cannot afford the costs of starting some new Science missions, like a mission to Jupiter's moon Europa, or the next-generation space astrophysics missions beyond the James Webb Space Telescope (JWST), at this time. It is important to know, however, that NASA is simply delaying these missions, not abandoning them.

The Agency's Science budget has grown much faster than NASA's total budget since FY 1993. In 1992, the Science budget represented 24 percent of the overall NASA budget while today, in the FY 2007 request, 32 percent of the Agency's budget is allocated to Science. NASA's Science budget is moderated to 1.5 percent growth in the FY 2007 budget request, compared with the amount appropriated for NASA in FY 2006 (as reflected in NASA's initial Operating Plan provided to the Committee) and then 1 percent per year thereafter through FY 2011.

In the FY 2007 budget request, there are some additional budget shifts within the Science portfolio, to adjust the balance of the program to better reflect our science priorities and consistent with the President's FY 2006 Budget Amendment. The resulting portfolio ensures that we maintain a suite of missions in all phases of development in each science discipline. In addition, within each Science area, we are working to assure that the mix of investments between missions and Research & Analysis (R&A) will ensure that we provide support to both future scientists and engineers.

As reflected in the FY 2006 Amendment to the President's Budget, a key aspect of adjusting the balance of the Science program is a significant reduction in the Mars program. This program had been previously slated to grow to $1.3 billion in FY 2010. This aggressive rate of growth had been built into the program over a period of several years. However, given our current budget limitations, had we left the Mars program unchanged, it would have accounted for almost one-quarter of the total Science budget in that timeframe. Maintaining that level of growth in the Mars program would have crowded out too many other high-priority science missions and research activities. We accomplished the reduction largely by deferring the Mars Sample Return mission and human precursor missions. Despite these reductions, the FY 2007 budget request maintains a robust program of Mars exploration, with a mix of orbiting and landed missions being launched at every 26-month opportunity.

The charge that Administrator Griffin has given to me is to deliver a robust and executable program that can be implemented in this resource-constrained environment. By "executable," we mean selecting, developing, and launching a slate of Science missions within cost and schedule targets. I would like to highlight some of the changes within our Science portfolio that will satisfy this directive. First, I would like to note that as part of this reorganization, the Science Mission Directorate will now have four major areas in our portfolio: Astrophysics, Earth Science, Heliophysics, and Planetary Science. The most significant change in this new structure is to break up the Earth-Sun System division into Earth Science and Heliophysics. This change will provide the Earth Science theme with added visibility and better reflects the work being done in these two disciplines. Since the reorganization is not yet final, the new division titles are not reflected in the FY 2007 budget request. My testimony below is based on this new organizational structure.

The FY 2007 **Astrophysics** (previously called Universe) budget request is $1,509 million. This budget supports a Hubble servicing mission in 2007-2008, pending final outcome of the second return-to-flight Shuttle mission. Gamma Ray Large Area Space Telescope GLAST is scheduled to launch at the end of FY 2007, and Kepler has been successfully confirmed for implementation. JWST will continue progress

toward entering development phase as a result of a recent replanning effort to address cost growth. The Space Interferometry Mission (SIM), which is planned for launch in 2015/2016, remains in formulation, and the Terrestrial Planet Finder (TPF) mission will be deferred. A review of Stratospheric Observatory for Infrared Astronomy (SOFIA) is being conducted in 2006, to determine whether it is appropriate to continue development of this project. If NASA decides to continue the project, we will incorporate the necessary funds into the FY 2007 budget via the Agency Operating Plan. The NuSTAR mission and the Keck observatory outriggers are cancelled. Finally, the Beyond Einstein Program is beginning a process of prioritization, with a goal of selecting a mission (either LISA, Con-X or Joint Dark Energy Mission) to enter development later this decade.

The FY 2007 **Earth Science** (previously part of Earth-Sun System) budget request is $1,530.7 million. With the Earth Observing System initial series of satellites now deployed, the focus is on exploiting their data in research, modeling, and applications, and on defining, formulating and implementing successor and complementary missions. For future missions, the largest challenge remains the delivery of instruments for the NOAA Polar Operating Environmental Satellite Series (NPOESS) Preparatory Project (NPP). In anticipation of development of a new baseline for NPOESS by the tri-agency Integrated Program Office, NASA has moved the NPP launch date to April 2008; further change is probable as NPOESS rebaselining is still in process. The Glory mission has also been confirmed to proceed to implementation. Launch of the Global Precipitation Measurement (GPM) mission is delayed to the end of 2012. NASA and the U.S. Geological Survey (USGS) received revised guidance from Office of Science and Technology Policy (OSTP) on Landsat, and NASA is proceeding with planning for the acquisition of a Landsat Data Continuity Mission as a free-flyer. In parallel, OSTP will work with NASA, USGS, and other agencies on a strategy for operational land observation. The Earth Systems Science Program (ESSP) Orbiting Carbon Observatory and Aquarius missions have been confirmed to proceed to implementation, and, thus, the ESSP back-up mission Hydros was not confirmed. The release of the next ESSP Announcement of Opportunity will be no earlier than FY2008. We have formed a joint working group with NOAA to plan the transition of NASA research results and observing capabilities to future NOAA operational systems, and will report on our progress as requested by the Congress. We eagerly await the release of the National Academy of Sciences decadal survey report this fall as a guide to our planning for future Earth Science missions.

The FY 2007 **Heliophysics** (previously part of Earth-Sun System) budget request is $679.9 million. The new Heliophysics Division manages three science flight programs that are funded in the FY 2007 budget request. These are the Solar Terrestrial Probe (STP), Living with a Star (LWS) and Explorer Programs. In addition, the Heliophysics Division will manage the New Millennium Program of technology flight validations. Three LWS projects will be supported in FY 2007. The Solar Dynamics Observatory (SDO) will be near completion of its fabrication phase at the end of this fiscal year, and near initiation of spacecraft integration and test activities. The SDO launch date has been changed from April 2008 to August 2008. The second STP mission, the Radiation Belt Storm Probe (RBSP) project, will be in a formulation phase in preparation for a mission confirmation review, and the Space Environment Testbed (SET) project will be completing payload hardware. The third STP mission, STEREO, is scheduled to launch two spacecraft to study the Sun later this year. The fourth STP mission, the Magnetosphere Multi-Scale (MMS) mission, the scientific goals of which were identified as the highest priority in the 2003 National Research Council decadal study, will also be in formulation phase this year. A Heliophysics Division Explorer program mission, the Interstellar Boundary Explorer (IBEX) project, is expected to be in a hardware construction phase. The plans for launch and operation of AIM and THEMIS, two other Explorer missions managed in the Heliophysics Division, remain unchanged. The release of the next Explorer Announcement of Opportunity (AO) is expected to be no earlier than FY2008.

The FY 2007 **Planetary Science** (previously called Solar System Exploration) budget request is $1,610 million to fund missions to solar system bodies, and to maintain the Deep Space Network. A key feature within this FY 2007 budget is the further adjustment of the balance of the science portfolio begun last year. The Mars exploration program was slated to grow very substantially in the President's FY 2004 and FY 2005 budget requests. The Mars program in the President's FY 2007 budget request continues to be an aggressive one, with a launch every optimal orbital opportunity. The MRO orbit insertion at Mars is coming up next week. This will be followed by the Phoenix launch in 2007, Mars Science Laboratory in 2009, and Mars Scout in 2011 (the AO for the 2011 Mars Scout is planned for release in April 2006, with proposals due in July 2006). Subsequent missions are being outlined in a community roadmapping activity now undergoing review by the National Academies. Deferred are Mars missions associated with preparation for human missions, in keeping with the planned time frame for human exploration, and a Mars sample return mission. The next Discovery Announcement of Opportunity was released in January 2006, with proposals due in April 2006, and selection expected by fall 2006. The first New Frontiers mission, New Horizons – Pluto, was successfully launched in January 2006. The second New Frontiers mission, Juno, is included in the FY 2007 budget request. The next New Frontiers AO is planned for no earlier than FY 2008. Astrobiology research funding is reduced 50 percent in the President's FY 2007 budget request for several reasons. The lower flight rate for Mars missions, plus the recognition that human exploration missions to Mars are further in the future than previously assumed, has reduced some of the urgency for rapid progress in astrobiology research. The Astrobiology program experienced rapid growth in funding several years ago, and this reduction brings it into balance with the rest of the research program.

The 15 percent reduction in research and analysis (R&A) funding is directly related to slowing rate of growth of Science Mission Directorate (SMD) programs and our desire to maintain a balance in the science and engineering workforces and an adequate number of missions to support them. We understand the concerns regarding these reductions and will work with the community to solicit their input on these programmatic issues. At the recent NASA Advisory Council meeting, the Science Committee requested a review of the R&A program to ensure that it is properly oriented toward the future, and provides adequate funding for younger researchers. We intend to discuss this issue further with the NASA Advisory Council, with representatives of the science community, and the Space Studies Board, and will seek their advice to ensure that we maintain an appropriate mix within each SMD Divisions between R&A, small-, medium-, and large-class missions. Following these discussions, should changes in the mix of R&A and mission investment be necessary, we will pursue that course of action via an adjustment in NASA's initial FY 2007 Operating Plan.

Community Involvement

The Science Mission Directorate (SMD) works continually with the science community to identify the highest science priorities and the best strategies and missions to address those priorities. These suggested priorities are provided through the decadal surveys and other reports of the National Academy of Sciences. We seek advice on implementation of these science priorities via the NASA Advisory Council and subordinate bodies. Implementation plans for each major science area, in the form of "community roadmaps" are developed in a partnership with the science community. During the development phase of major missions, we draw on the science community when needed for assessment of science impacts of potential content or schedule changes, as we did recently with JWST. For operating missions, we seek science community peer review to determine the merits of extending the operation of missions that have exceeded their primary mission lifetimes. After such reviews, NASA has extended the mission operating life of several Earth Science missions including Tropical Rainfall Measurement Mission (TRMM) and Terra, Heliophysics missions such as Solar and Heliospheric Observatory (SOHO) and both Voyager

spacecraft, and Astrophysics missions including Chandra and Wilkinson Microwave Anisotropy Probe (WMAP). Dialog with the community will be increasingly important as we move forward to implement their highest priorities in a constrained budget environment.

At the present time, SMD is working to establish a suite of five new advisory subcommittees to the NASA Advisory Council; there will be a subcommittee for each of the four major SMD science areas, and a fifth to provide guidance on planetary protection. Key tasks for the four science subcommittees will be to provide tactical and programmatic advice within the context of National Research Council strategic guidance and to contribute scientific expertise to SMD's long-term program planning efforts.

Interagency/International Cooperation

NASA's science program continues to be broadly international. One example is the MRO spacecraft, due to enter Mars orbit in a week, and carries an Italian-provided radar. The James Webb Space Telescope, one of our flagship astrophysics missions, includes significant contributions from the European Space Agency. And two of our upcoming major launches, the CALIPSO and CloudSat Earth science missions, also feature major foreign collaborations. Carrying on a long-standing practice of annual meetings, we are planning a comprehensive review of cooperative space science activities with the European Space Agency in late June; a comparable Earth science review is also being planned. The Directorate has proposed establishment of a framework for international science cooperation in the exploration context as a theme for discussion at the next biennial meeting of the international Committee on Space Research (COSPAR), to be held in Beijing this coming July.

SMD also works closely with other Federal agencies to push the frontiers of science and maximize the science return of our activities. For example, we collaborate with the National Science Foundation (NSF) on astronomy, suborbital, meteorite, and Antarctic research programs. NASA also has a long-standing relationship developing and launching polar-orbiting and geostationary environmental satellites for NOAA. We are currently involved with the Department of Defense, NOAA, and the USGS in remote sensing activities and the development of the next generation of environmental satellites. I am pleased to announce that the synopsis for the Landsat Data Continuity Mission, a collaborative mission between NASA and USGS, was released last week. We also have collaborative agreements in Earth applications with about a dozen Federal government agencies, from the Department of Agriculture to USGS. Collaborations with domestic and international partners remain an important component in NASA's science programs.

Implementing the Vision for Space Exploration

The human exploration of space beyond low-Earth orbit is a core element of NASA's strategic plan. The fundamental goal of the Vision for Space Exploration is "*To advance U.S. scientific, security, and economic interests through a robust space exploration program.*" It is the responsibility of SMD, working with the Exploration Systems Mission Directorate (ESMD), to make sure that NASA conducts the science that enables human space exploration, as well as the science that is enabled by human space exploration, in the context of the Agency's and the Nation's overall science priorities.

Within our research programs, SMD supports science that enables human exploration. For instance, within our Heliophysics research program, we are supporting the science required to understand and mitigate the radiation environments that human space explorers will be working in beyond the Earth's magnetosphere, and within our Planetary Science research program we are supporting the study of the Moon, Mars, and other solar system bodies that are the destinations for the human exploration program.

Working with ESMD to realize the science required to enable human exploration of the Moon, SMD is playing a traditional program science role in ESMD's lunar robotic program. ESMD is funding the lunar robotic missions, and SMD is providing scientific advice on instrument selection, development, and related matters. Important aspects of lunar science were addressed in the NRC's recent solar system exploration decadal survey, New Frontiers in the Solar System. At the present time, SMD is working with the NASA Advisory Council on a near-term plan to review and extend these and other identified science priorities that can be addressed on the Moon in the context of the broader science program. This process is expected to also involve the NRC Space Studies Board. Anticipating science opportunities that will be enabled by the lunar human exploration missions, SMD will be evaluating the potential for lunar science. Potential science opportunities enabled by human exploration activities will compete in the same prioritization process as the rest of the SMD science program, since the funds come from the same pool.

Within the zone of intersection between the science and exploration spheres are the choices that will be made on exploration architectures and systems -- some choices that are cost neutral for exploration may nevertheless be more beneficial for science. NASA, the NAC, and the Space Studies Board will be undertaking a set of workshops and studies this year to identify science priorities and science opportunities, within the context of the decadal surveys, which will inform such choices. For example we are discussing with the Board the development of a science strategy for the Moon that is consistent with the Board's existing science advice.

Conclusion

In conclusion, NASA faces significant challenges and opportunities in implementing a robust and exciting Science program. In a time of constrained resources and a large number of compelling future Science missions, setting priorities is more important than ever. NASA is committed to undertaking the necessary prioritization studies in a joint activity with the science community via the National Academies and NASA's advisory committee apparatus. Access to the judgment of active members of the research community is absolutely vital in this endeavor, and we are dependent on the continued support and assistance of the broader science and industrial communities and Congress to successfully implement the highest priority programs in a cost-effective manner.

Once again, thank you for the opportunity to testify today. Mr. Chairman and Members of the Committee, I would be pleased to answer any questions that you may have.